

Detailed Action

1. The Applicant's amendment filed on November 11th, 2010 was received. Claims 1 was amended. Claims 3, 6-10 and 21 were cancelled. Claims 11-19 were withdrawn from further consideration.
2. The text of those sections of Title 35, U.S.C. code not included in this action can be found in the prior Office Action (issued on May 11th, 2010).

Claim Rejections - 35 USC § 103

3. Claims 1-2, 4,5, 20, 22,23 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zuber et al. (U.S. Patent No. 6,156,449) in view of Yano (U.S. Patent No. 5,380,806) and Tsai et al. (U.S. 6,514,296 B1) and Yoshino et al. (U.S. Pub No. 2002/0048654 A1).

With respect to claims 1, 5, 20 and 24, Zuber et al disclose a catalyst layer for polymer electrolyte fuel cells (title) wherein the homogenized ink may be applied on to the substrate material by means of various techniques. These include, for example, spraying, brushing, spreading or printing. After coating the substrate material with the ink, or dispersion, the coating obtained is dried at an elevated temperature. Ionomer, precious metal complex compounds and the drying temperature must be appropriately selected to achieve optimum results after drying (Col 6 lines 35-55).

Zuber et al also teach that based on protocol II of U.S. Pat. No. 5,234,777 an MEA was produced as follows: a dispersion of 1 g support catalyst (Degussa, 20% Pt on Vulcan XC72), 10 g of a 5% NAFION.RTM. Solution in low-boiling alcohols (Aldrich, Karlsruhe), 3.3 g glycerol (surfactant), 8.2 g water and 0.47 g 1 N NaOH solution was prepared. The mixture was dispersed in an ultrasound bath. A NAFION.RTM. 115 membrane in the Na.sup.+ form was attached to a heated plate. The mixture was applied onto one side of the membrane and dried at 150.degree. C. This procedure was repeated until the desired platinum load of 0.25 mg Pt/cm.sup.2 was reached. The reverse side of the membrane was then coated in the same way. Before being used in the PEM fuel cell, the membrane coated with catalyst was reprotonated in 0.5 M sulfuric acid solution. The total platinum load (sum of the two catalyst layers) of the membrane electrode assembly was 0.5 mg/cm.sup.2 (Col 8 lines 1-15). (Examiner notes that since the ink composition of Zuber et al contains water as a constituent then the ink composition of Zuber et al is water based).

With respect to the amount of catalyst in the ink solution the disclosure Zuber et al as differs from Applicant's claims in that Zuber et al do not specifically teach 5%-75%wt. of electrocatalyst claimed by Applicant. However, Zuber et al. recognize the need for adjusting the amount of catalyst in the ink. Zuber et al. teach that the weight ratio of the conductive carbon particles to the ionomer in the ink is typically between 5:1 and 1:1, preferably between 4:1 and 2:1. The desired precious metal load (area concentration in mg/cm.sup.2) of the finished catalyst layer can be adjusted by means of a corresponding weight ratio of the precious metals to the carbon particles in the ink,

with a given layer thickness. Weight ratios of the precious metals to the carbon particles of between 1:10 and 4:1 are preferably used (Col 6 lines 25-35).

Therefore, it would have been within the skill of the ordinary artisan to adjust the amount of electrocatalyst in the ink of Zuber et al to be within the Applicants claimed electrocatalyst range in order achieve the desired catalyst load. *Discovery of optimum value of result effective variable in known process is ordinarily within skill of art. In re Boesch*, CCPA 1980, 617 F.2d 272, 205 USPQ215.

Zuber et al. does not specifically teach leveling the deposited catalyst ink. However, Yano disclose an ink composition (title) wherein when the amount of the leveling agent is less than about 0.1 part by weight, a rough surface of the coating film attributed to the remainder of the foam generated at the time of the printing and the screen mesh is not sufficiently leveled, and pinholes are likely to be formed on the surface after drying and curing, so that the film tends to have a nonuniform thickness (Col 6 lines 25-45). Therefore it would have been obvious to incorporate the leveling procedure of Yano into the process of Zuber et al. because Yano teach that if the mesh is not sufficiently leveled, pinholes are likely to be formed on the surface after drying and curing, so that the film tends to have a nonuniform thickness (Col 6 lines 25-45).

The disclosure Zuber et al differs from Applicant's claims in that Zuber et al. do not disclose drying times as claimed by Applicant. Zuber et al teach that thermal damage to the ionomer can consist in degradation of the proton-conducting functional groups, such as e.g. --SO₃H. In addition, irreversible changes to the structure of the polymer are possible which have a disadvantageous effect on the mechanical

properties or the proton conductivity of the polymer. For tetrafluoroethylene-fluorovinyl ether copolymers with acid functions, e.g. NAFION.RTM. by Du Pont de Nemours, the suitable drying temperatures are between 60 and 200 °C., preferably between 70 and 160. °C (Col 6 lines 60-67).

With respect to the length of time of the drying step, the disclosure Zuber et al as modified by Yano and Tsai et al. differs from Applicant's claims in that Zuber et al as modified by Yano and Tsai et al. do not disclose drying times as claimed by Applicant. However, Yano recognize the need for adjusting the residence time of the polymer membrane in the drying station. Yano teach that if the mesh is not sufficiently leveled, pinholes are likely to be formed on the surface after drying and curing, so that the film tends to have a nonuniform thickness (Col 6 lines 25-45). Therefore, it would have been within the skill of the ordinary artisan to adjust the leveling time of the polymer membrane of Zuber et al as modified by Yano and Tsai et al. to within the Applicants claimed leveling time range in order to guarantee uniform thickness. *Discovery of optimum value of result effective variable in known process is ordinarily within skill of art. In re Boesch*, CCPA 1980, 617 F.2d 272, 205 USPQ215.

Zuber et al as modified by Yano does not specifically teach controlling the temperature and humidity. However, Tsai et al. disclose a method of making an energy storage device (title) wherein the coating solution is applied to the support by a spray method, cured, and optionally repeated to increase the thickness. A preferred procedure is to apply the coating solution to the substrate at a temperature of 0-150 °C by means of an ultrasonic or other spray nozzle with a flow rate of around 0.1-5 ml/min

in a carrier gas composed of nitrogen, oxygen and/or other reactive and inert gases. The coating characteristics are controlled by the partial pressure of oxygen and other reactive gasses (Col 13 lines 40-50). Usually, constant temperature and humidity are important to obtain an even coat (Col 19 lines 40-50). Therefore it would have been obvious to one of ordinary skill in the art to incorporate the controlling of the temperature and humidity of Tsai et al. into the leveling process of Zuber et al as modified by Yano because Tsai et al. teach that usually, constant temperature and humidity are important to obtain an even coat (Col 19 lines 40-50).

Furthermore, it would have been within the skill of the ordinary artisan to adjust the temperature and humidity of the production process of Zuber et al as modified by Yano and Tsai et al. to within the Applicants claimed temperature and humidity range because discovering the optimum or workable range involves only routine skill in the art and since processing temperature and humidity determines the quality and evenness of the coat.. *Discovery of optimum value of result effective variable in known process is ordinarily within skill of art.* In re Boesch, CCPA 1980, 617 F.2d 272, 205 USPQ215.

With respect to the coating step occurring in a coating compartment and the leveling step occurring in a leveling compartment, the coating and leveling steps of Zuber et al as modified by Yano and Tsai et al. takes place in the same compartment which anticipates the limitation of to the coating step occurring in a coating compartment and the leveling step occurring in a leveling compartment as evidenced by the Examiner's interpretation of claim 21 wherein the Applicant claims that "the coating step

(a) and the leveling step (b) are performed in one large compartment comprising a coating section and a leveling section.”

With respect to the length of time of the leveling step, the disclosure Zuber et al as modified by Yano and Tsai et al. differs from Applicant's claims in that Zuber et al as modified by Yano and Tsai et al. do not disclose leveling times as claimed by Applicant. However, Yano recognize the need for adjusting the residence time of the polymer membrane in the drying station. Yano teach that if the mesh is not sufficiently leveled, pinholes are likely to be formed on the surface after drying and curing, so that the film tends to have a nonuniform thickness (Col 6 lines 25-45). Therefore, it would have been within the skill of the ordinary artisan to adjust the leveling time of the polymer membrane of Zuber et al as modified by Yano and Tsai et al. to within the Applicants claimed leveling time range in order to guarantee uniform thickness. *Discovery of optimum value of result effective variable in known process is ordinarily within skill of art. In re Boesch*, CCPA 1980, 617 F.2d 272, 205 USPQ215.

Zuber et al as modified by Yano and Tsai et al. do not specifically teach a surfactant amount in the range of 0.1%wt to 20% wt. However, Yoshino et al. disclose a printing process wherein In each of the case where the crosslinking agent is added to the dispersion of the alumina hydrate and the case where the crosslinking agent is impregnated into the ink-receiving layer, the amount to be added is preferably within a range of from 0.01 to 20% by weight, more preferably from 0.05 to 10% by weight based on the total weight of "the alumina hydrate and the binder". So far as the amount falls within this range, the occurrence of beading and feathering can be prevented even

when printing is conducted on the resulting printing medium with inks containing a great amount of a surfactant (Paragraph 0126). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the surfactant amount of Yoshino et al. in the process of Zuber et al as modified by Yano and Tsai et al. because Yoshino et al. teach that surfactant amount in this range prevents the occurrence of beading and feathering.

Zuber et al, Yano et al. and Tsai et al as modified by Yoshino et al. are analogous art because they are from the similar problem solving area of printing a solids and surfactant based solution onto a substrate.

With respect to claim 2, Zuber et al also teach that based on protocol II of U.S. Pat. No. 5,234,777 an MEA was produced as follows: a dispersion of 1 g support catalyst (Degussa, 20% Pt on Vulcan XC72), 10 g of a 5% NAFION.RTM. Solution in low-boiling alcohols (Aldrich, Karlsruhe), 3.3 g glycerol (organic solvent), 8.2 g water and 0.47 g 1 N NaOH solution was prepared. (Col 8 lines 1-15).

With respect to claim 4, Zuber et al. teach that as shown by FIGS. 1 to 3, the catalyst layers according to the invention may be used to produce various components of fuel cell systems which can be marketed separately. FIG. 2, for example, shows a gas diffusion electrode, which is obtained when a gas diffusion structure is used as

substrate material for the catalyst layer. This may be carbon fiber paper or nonwoven carbon fabric, for example (Col 7 lines 15-25).

With respect to claims 22 and 23, the disclosure Zuber et al as differs from Applicant's claims in that Zuber et al do not specifically teach 5 to 20% wt of ionomer as claimed by Applicant. However, Zuber et al. recognize the need for adjusting the amount of ionomer in the ink. Zuber et al. teach that the weight ratio of the conductive carbon particles to the ionomer in the ink is typically between 5:1 and 1:1, preferably between 4:1 and 2:1. The desired precious metal load (area concentration in mg/cm.sup.2) of the finished catalyst layer can be adjusted by means of a corresponding weight ratio of the precious metals to the carbon particles in the ink, with a given layer thickness. Weight ratios of the precious metals to the carbon particles of between 1:10 and 4:1 are preferably used (Col 6 lines 25-35).

Therefore, it would have been within the skill of the ordinary artisan to adjust the amount of ionomer in the ink of Zuber et al to be within the Applicants claimed electrocatalyst range in order achieve the desired catalyst load. *Discovery of optimum value of result effective variable in known process is ordinarily within skill of art. In re Boesch*, CCPA 1980, 617 F.2d 272, 205 USPQ215.

Response to Arguments

4. Applicant's arguments filed on November 3rd, 2010 have been fully considered but they are not persuasive.

Applicant's principal arguments are

(a). As admitted by the Examiner, the Zuber reference does not disclose or teach any leveling process - and certainly not the leveling of the catalyst ink deposits in a leveling compartment for 1 to 10 minutes at 60 to 100% relative humidity and a temperature of 10 to 60 °C. In fact, Zuber does not even disclose a coating process under conditions of 60 to 100% relative humidity and a temperature of 10 to 60 °C. Zuber is completely silent to any leveling of an ink and certainly is silent with respect to the conditions now set forth in amended claim 1. The Examiner's reliance on the Yano reference to provide these missing teachings is misplaced. Yano, as stated in our previous responses, does not disclose a leveling step or process, but rather merely the use of a leveling agent in a totally different process.

(b) Yano does not teach or suggest *holding the substrate and the deposited catalyst ink in a leveling compartment for 1 to 10 minutes wherein the relative humidity is 60 to 100% and the temperature is 10 to 60 °C*, as now required by claim 1.

Consequently, the combination of Zuber and Yano can not lead to the process of claim 1. At most, the combination of Zuber and Yano leads to the addition of a leveling agent to the catalyst ink in a concentration greater than 0.1 parts by weight. There is no

teaching or suggestion in either reference or in their combination that would lead a skilled artisan to the application of a separate leveling process in a leveling compartment for 1 to 10 minutes under a relative humidity of 60 to 100% and a temperature of 10 to 60 °C. The Examiner also alleges that the Tsai reference teaches the importance of constant humidity and temperature in order to obtain an even coating. That may be, but this has nothing to do with the present invention. Tsai is directed to the manufacture of double-layer bipolar capacitors (see the field of invention). Tsai discloses a printing process for a two-component epoxy material having a useful life of about 30 minutes (see column 29, lines 44-53). Tsai does not disclose any catalyst inks, nor would one skilled in the industry even look to Tsai in attempting to address the shortcomings of Zuber.

(c) The claimed invention also has additional claim limitations not present in any of the cited art. For instance, claim 1, as amended herein, requires that the catalyst-coated substrate be dried at a temperature in the range of 40 to 150 °C for 1 to 10 minutes. These claim limitations also are not taught or suggested by the cited prior art.

In response to Applicant's arguments, please consider the following comments.

(a) and (b) Zuber et al. does not specifically teach leveling the deposited catalyst ink. However, Yano disclose an ink composition (title) wherein when the amount of the leveling agent is less than about 0.1 part by weight, a rough surface of the coating film attributed to the remainder of the foam generated at the time of the printing and the screen mesh is not sufficiently leveled, and pinholes are likely to be formed on the surface after drying and curing, so that the film tends to have a nonuniform thickness (Col 6 lines 25-45). Therefore it would have been obvious to incorporate the leveling procedure of Yano into the process of Zuber et al. because Yano teach that if the mesh is not sufficiently leveled, pinholes are likely to be formed on the surface after drying and curing, so that the film tends to have a nonuniform thickness (Col 6 lines 25-45).

Zuber et al as modified by Yano does not specifically teach controlling the temperature and humidity. However, Tsai et al. disclose a method of making an energy storage device (title) wherein the coating solution is applied to the support by a spray method, cured, and optionally repeated to increase the thickness. A preferred procedure is to apply the coating solution to the substrate at a temperature of 0-150 °C by means of an ultrasonic or other spray nozzle with a flow rate of around 0.1-5 ml/min in a carrier gas composed of nitrogen, oxygen and/or other reactive and inert gases. The coating characteristics are controlled by the partial pressure of oxygen and other reactive gasses (Col 13 lines 40-50). Usually, constant temperature and humidity are important to obtain an even coat (Col 19 lines 40-50). Therefore it would have been obvious to one of ordinary skill in the art to incorporate the controlling of the temperature and humidity of Tsai et al. into the leveling process of Zuber et al as modified by Yano

because Tsai et al. teach that usually, constant temperature and humidity are important to obtain an even coat (Col 19 lines 40-50).

Furthermore, it would have been within the skill of the ordinary artisan to adjust the temperature and humidity of the production process of Zuber et al as modified by Yano and Tsai et al. to within the Applicants claimed temperature and humidity range in order to obtain an even coat.. *Discovery of optimum value of result effective variable in known process is ordinarily within skill of art. In re Boesch*, CCPA 1980, 617 F.2d 272, 205 USPQ215.

(c) Zuber et al also teach that based on protocol II of U.S. Pat. No. 5,234,777 an MEA was produced as follows: a dispersion of 1 g support catalyst (Degussa, 20% Pt on Vulcan XC72), 10 g of a 5% NAFION.RTM. Solution in low-boiling alcohols (Aldrich, Karlsruhe), 3.3 g glycerol (surfactant), 8.2 g water and 0.47 g 1 N NaOH solution was prepared. The mixture was dispersed in an ultrasound bath. A NAFION.RTM. 115 membrane in the Na.sup.+ form was attached to a heated plate. The mixture was applied onto one side of the membrane and dried at 150.degree. C. This procedure was repeated until the desired platinum load of 0.25 mg Pt/cm.sup.2 was reached. The reverse side of the membrane was then coated in the same way. Before being used in the PEM fuel cell, the membrane coated with catalyst was reprotonated in 0.5 M sulfuric acid solution. The total platinum load (sum of the two catalyst layers) of the membrane electrode assembly was 0.5 mg/cm.sup.2 (Col 8 lines 1-15).

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Conclusion

5. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not

mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ben Lewis whose telephone number is 571-272-6481. The examiner can normally be reached on 8:30am - 5:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick Ryan can be reached on 571-272-1292. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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Examiner, Art Unit 1726

/Patrick Joseph Ryan/
Supervisory Patent Examiner, Art Unit 1726